The near-Earth meteoroid flux, speed distribution, and uncertainty

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ABSTRACT

Meteoroids are known to pose a threat to spacecraft; they can puncture components, disturb spacecraft attitude, and possibly create secondary electrical effects. Accurate environment models are therefore critical for mitigating meteoroid-related risks. While there are several meteoroid environment models available for assessing spacecraft risk, the uncertainties associated with these models are not well understood. Because meteoroid properties are derived from indirect observations such as meteors and impact craters, the uncertainty in the meteoroid flux is potentially quite large.

We combine existing meteoroid flux measurements with new radar and optical meteor data to improve our characterization of the meteoroid flux onto the Earth and its velocity distribution. We use data extracted from the NASA all-sky network, the Canadian Automated Meteor Observatory, and the Canadian Meteor Orbit Radar. We improve our characterization of the observed meteoroid speed distribution by incorporating modern descriptions of the ionization efficiency (e.g., Thomas et al., 2016). We also present estimates of the uncertainties associated with our meteoroid flux distribution.

Finally, we discuss the implications for spacecraft. Our model is constrained by the cratering rate on the space-facing surface of LDEF, and thus the risk posed to spacecraft by meteoroid-induced physical damage is the least uncertain component of our model. Other sources of risk, however, may vary. For instance, a lower average meteoroid speed would require a higher meteoroid mass flux in order to match the LDEF crater counts, leading to higher predicted rates of attitude disturbances.